The Functional Impact of the Absence of a Bulbocavernosus Reflex in the Postoperative Period After a Motor-Complete Traumatic Spinal Cord Injury

Nicolas Greciet, Jean-Marc Mac-Thiong, MD, PhD, Bich-Han Nguyen, MD, BSc, and Andréane Richard-Denis, MD, MSc

Objective: The aim of the study was to investigate the impact of the absence of a bulbocavernosus reflex in the postoperative period on the neurological and functional recovery 6–12 mos after a motor-complete traumatic spinal cord injury.

Design: A retrospective review of a prospective database was completed among 66 patients. The functional and neurological statuses between individuals with and without a bulbocavernosus reflex were compared. A general linear model was used to investigate the association between the postoperative bulbocavernosus reflex status and the functional outcome, using the Spinal Cord Independence Measure.

Results: Forty percent of the cohort had no bulbocavernosus reflex 5 days after trauma. Individuals with a bulbocavernosus reflex showed a higher rate of American Spinal Injury Association Impairment Scale grade conversion, improvement of the level of injury, and higher functional scores; however, it did not reach a significant level. The bulbocavernosus reflex status in the postoperative period was not significantly associated with the functional status 6–12 mos after injury.

Conclusions: Late recovery of the bulbocavernosus reflex in the postoperative period may be associated with poorer neurological and functional outcome for individuals sustaining a motor-complete traumatic spinal cord injury, for which the prognosis estimation is limited. A prospective study including a larger number of patients is necessary to confirm results of this study.

Key Words: Spinal Cord Injury, Acute Care, Spinal Shock, Bulbocavernosus, Outcome

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From the Faculty of Medicine, Department of Medicine, University of Montreal, Montreal, Quebec, Canada (NG, B-HN, AR-D); Hôpital du Sacré-Cœur de Montréal, Montreal, Quebec, Canada (J-MM-T, AR-D); Sainte-Justine University Hospital Research Center, Montréal, Quebec, Canada (J-MM-T); Faculty of Medicine, Department of Surgery, University of Montreal, Montreal, Quebec, Canada (J-MM-T); and Institut de réadaptation Gingras-Lindsay de Montréal, Montréal, Quebec, Canada (B-HN).

All correspondence should be addressed to: Andréane Richard-Denis, MD, MSc, Research Center, Hopital du Sacré-Cœur de Montréal, Department of Physical Medicine and Rehabilitation, 5400 Gouin ouest, Montréal, QC, Canada H4J 1C5.

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What Is Known

- The bulbocavernosus reflex (BCR) is a spinal reflex commonly evaluated after spinal cord injury (SCI). Despite being a key feature of the physical examination, the pathophysiology and clinical significance of the presence of BCR after an acute SCI remain largely unknown.

What Is New

- This study showed that individuals sustaining an acute motor-complete traumatic SCI may display a late recovery of the BCR in the postoperative period, which may be associated with poorer neurological and functional outcome. This study is also the first to demonstrate the presence of the spinal shock in severe but incomplete SCI.

Traumatic spinal cord injuries (TSCIs) are life-changing incidents heavily linked to permanent psychological, neurological, and functional disabilities. Traumatic spinal cord injury may lead to loss of motor function and sensation, affecting mobility, self-care, respiration, and sphincter management. It is of key importance to establish functional prognosis as early as possible to give proper expectations to the patient and implement rapidly a personalized rehabilitation plan.[1]

Many studies show that the initial severity of the TSCI has a critical impact on the long-term neurological[2–4] and functional[2,3,5–10] outcomes. The sacral examination, as an important step of the International Standard Neurologic Classification of Spinal Cord Injury (ISNCSCI), is used to determine the extent and severity of the TSCI.[9] Though not part of the ISNCSCI, the bulbocavernosus reflex (BCR) is commonly evaluated as it helps provide valuable information, such as distinguishing conus medullaris from cauda equina syndromes[11] or determining the presence or absence of spinal shock.[12] The BCR is a spinal reflex mediated by nerve segment S2–S4 and consists in the contraction of the bulbocavernosus muscle and anal contraction after squeezing of the glans penis or clitoris.[9] The absence of a BCR in the acute phase after a SCI may suggest presence of spinal shock, a complex clinical concept defined as the temporary loss of spinal reflexes below the level of injury.[11,13] As it is one of the first spinal reflexes to recover during the spinal shock process, the BCR is a key feature of the physical examination after a severe TSCI.[12]

If the pathophysiology underlying the occurrence of spinal shock suggests the presence of a complete SCI,[12,14] it is largely unknown whether its time course may represent a predictive factor of the outcome. More specifically, it is unknown whether a late recovery of the BCR in the postoperative phase, where the acute rehabilitation process is started more significantly, is associated with the long-term neurological or functional outcome after a severe TSCI. However, this information could greatly help acute clinicians in refining their methods to predict function for patients for whom the recovery prognosis is generally limited, but may still vary in many cases.[15] Moreover, a better understanding of the clinical impact of the BCR would shed light on the spinal shock, which was long considered as an important limitation for interpreting the acute neurological examination after TSCI.[16] Accordingly, the main objective of this study was to determine the impact of the absence of a BCR reflex in the postoperative phase on the functional status 6–12 mos after an acute motor-complete TSCI. The neurological outcome was also studied as a secondary objective using patients who had available data, which included neurological level of injury (NLI), American Spinal Injury Association impairment scale (AIS) grade, and motor score.

METHODS

Study Population

This study consisted in a review of a prospective database collected in a single level 1 trauma center specialized in spinal cord injury (SCI) care. A total of 66 adult patients with acute TSCI from C1 to L1 consecutively admitted between April 2010 and August 2017 (57 males and 9 females; 42.7 ± 16.6 yrs old) were studied. Patients were included if they experienced an acute cervical (C1–C8) or thoraco-lumbar (T1–L1) motor-complete TSCI, which refers to the American Spinal Injury Association (ASIA) Impairment Scale grades A (complete injury) and B (motor-complete and sensory-incomplete injury). Included patients underwent surgical procedures at our institution, had a postoperative neurological assessment within 10 days from surgery, which included a thorough evaluation of the BCR status, and presented at their follow-up visit in the subacute to chronic phase between 6 and 12 mos after injury. Patients with abnormal signal located at the conus medullaris on the magnetic resonance imaging at admission were excluded. When no magnetic resonance imaging was performed at admission, patients with a vertebral or NLI including T12 or L1 were excluded to avoid any involvement of the conus medullaris. Ethics clearance by the institutional review board and written informed consent were duly obtained for this study. This study conforms to all strengthening the reporting of observational studies in epidemiology guidelines and reports the required information accordingly (see Supplemental Checklist, Supplemental Digital Content 1, http://links.lww.com/PHM/A958).

Main Independent Variable

Two groups were defined based on the postoperative BCR status dichotomized as present or absent. A BCR was considered present when anal contraction followed squeezing of the glans penis or clitoris.[11,13] Thus, group 1 (BCR−) included individuals without a BCR, whereas group 2 (BCR+) included individuals with a BCR at the sacral examination in the postoperative period after the TSCI.

Covariates

Sociodemographic, clinical, and trauma-related information was collected. Sociodemographic data included age, sex, and marital status (alone vs. married/common-law vs. family member/other). Clinical data included the occurrence of pneumonia, urinary tract infection and pressure ulcers, the most frequent medical complications after an acute TSCI.[17] Pneumonia was diagnosed using clinical features and confirmed by a radiologist using chest X-rays.[18] Urinary tract infections were diagnosed using criteria from the 2006 Consortium for Spinal Cord Medicine Guidelines for healthcare providers,[19] and pressure ulcers were diagnosed using clinical guidelines defined by the National Pressure Ulcer Advisory Panel.[20] A complication rate was calculated, referring to the proportion of patients who developed one of the previously mentioned complications during their stay at the acute care center, and was expressed as a percentage. Presence of spasticity was noted as the main neurological complication based on physical findings and symptoms reported by the patient[21,22] and required two of the following three criteria: (*a*) presence of increased velocity-dependent muscle tone at physical examination (Modified Ashworth scale score >1), (*b*) spasm and/or clonus noted at physical examination, and (*c*) spasm and/or clonus reported by the patient. Other clinical data consisted in hospital length of stay, defined as the number of days from admission to discharge from the acute SCI center; surgical delay defined as the time (in hours) between the injury and the time of incision (dichotomized as less or more than 24 hrs); delay from trauma to postsurgical neurological assessment, defined as the number of days from trauma to postsurgical assessment; delay from surgery to postsurgical neurological assessment, defined as the number of days between surgery and postsurgical assessment; and comorbidities, based on the Charlson Comorbidity Index, which considers the different comorbidities based on the adjusted relative risk of 1-yr mortality.[23]

Information pertaining to the characteristics of the TSCI was also retrieved from our prospective database. Initial severity of the TSCI was reported using the AIS grade and the NLI based on the ISNCSCI assessed within 72 hrs from the injury.[9] The neurological examination is performed in our center in the preoperative and postoperative periods after admission for a TSCI. Although the preoperative neurological assessment is generally performed by one member of the spinal surgery team, the postoperative ISNCSCI assessment and BCR evaluation are systematically and thoroughly performed by a single trained physical medicine and rehabilitation physician specialized in SCI management who undertook the InSTeP ASIA learning program. Because the initial neurological assessment is suggested to be performed within 72 hrs after trauma,[24] if the postoperative assessment was available within that period, the latter was used for determining the initial NLI and AIS grade. Otherwise, the preoperative assessment was used. However, because the BCR status was generally missing in the preoperative period, the BCR reflex was always determined based on the postoperative assessment. In accordance with the main objective of this study, only patients with motor-complete

TSCI (AIS grades A and B) were considered. The NLI was divided into four categories: C0–C4, C5–C8, T1–T8, and T9–L1. Trauma severity was assessed using the Injury Severity Score.[25] Presence and severity of concomitant traumatic brain injury (TBI: none vs. mild vs. moderate vs. severe) were also documented.

Outcome Assessment

The third version of the Spinal Cord Independence Measure (SCIM) questionnaire was used to determine the functional status in the subacute to chronic phase, performed during the medical follow-up appointment. The 12-mo posttrauma SCIM was considered, but if unavailable, the 6-mo posttrauma SCIM scores were used. Indeed, a recent study indicated that the functional improvement does not reach a clinically significant level of 4 points or more from 6 to 12 mos after injury,[26] allowing us to consider SCIM scores regardless of the follow-up date, without significantly affecting the results. The SCIM is a reliable and sensitive tool specific to SCI, aimed at evaluating patients' ability to perform daily living activities independently.[27] It assesses three domains: self-care (6 items evaluating feeding, grooming, bathing, and dressing); respiration and sphincter management (4 items); and mobility and transfers (9 items evaluating bed, indoor, and outdoor mobility). The total SCIM score can range between 0 and 100 points, divided between the three domains. A higher SCIM score reflects a higher functional status. The score for each domain is proportional to its relative importance,[27] with self-care ranging between 0 and 20, whereas respiration/sphincter management and mobility/transfers scores both ranging between 0 and 40. The three SCIM subscores (self-care; respiration and sphincter management; mobility and transfers) as well as the total SCIM score were considered. The neurological status (ISNCSCI) was also assessed at the time of follow-up.

Statistical Analyses

IBM SPSS Statistics Version 25 software package was used for statistical analyses. Our cohort was described using median and interquartile range (IQR) for continuous variables, and proportions or percentages for categorical variables, according to the Kolmogorov-Smirnov test demonstrating a nonnormally distributed data. Group comparisons (using Mann-Whitney *U* tests for continuous variables and χ^2 tests for categorical variables) were performed with respect to demographics, clinical, and trauma characteristics. The total SCIM score, the SCIM subscores (self-care, respiration and sphincter management, and mobility) and the AIS motor score were also compared. The ASIA Impairment Scale grade conversion rate was also compared for the two groups using χ^2 tests.

A general linear model (GLM) using multivariable linear regression analyses was used to evaluate the strength of association between the absence of a BCR in the postoperative period and the functional outcome (SCIM total score) considering sociodemographic, clinical, and trauma-related data as covariates. Univariate regression analyses were first used to determine the strength of association between each independent variable and the studied outcome to select candidate predictors to be included in the GLM for a cohort of 45 patients.[28] A significance level of $P = 0.1$ was used only at this step to avoid a type 2 error.[29] By removing the variables with the highest *P* values, four variables were then entered in the GLM: (*a*) presurgical NLI (C0–C4 vs. C5–C8 vs. T1–T8 vs. T9–L1); (*b*) presence of complications (dichotomized as presence or absence); (*c*) presurgical motor score (continuous); and (*d*) the presence of BCR (dichotomized as presence or absence), as being our main independent variable. The strength of association was assessed using the β coefficient, and the R^2 value was used as the estimator of the variance explained by the final model. The significance level was set to $P = 0.05$ for all statistical analyses.

RESULTS

A total of 66 patients fulfilled the inclusion criteria. Among them, 21 were excluded based on the presence of signal abnormality at the conus medullaris on the magnetic resonance imaging, for a total of 45 patients included in the final cohort. A total of 40% (18/45) of the cohort had no BCR in the postoperative period after their motor-complete TSCI. Among them, almost 61% sustained a complete SCI (AIS A) and 80% of them sustained a cervical injury (Table 1). The postoperative neurological assessment was completed 7 days after the trauma for group 1 and after 4 days for group 2, which consisted in a nonsignificant difference ($P = 0.68$). The surgical delay was also similar for the two groups.

Table 1 shows the sociodemographic and clinical characteristics of the entire cohort and both groups. Groups 1 and 2 were similar with regard to sociodemographic characteristics (age, sex) and characteristics of the injury (concomitant TBI, Injury Severity Score, severity, and level of the injury) and clinical evolution during acute care (medical complications and length of stay).

Two-thirds of the entire cohort (30/45) had their follow-up 12 mos after their injury, whereas the rest (15/45) were followed 6 mos after injury. These two groups showed similar baseline characteristics, in terms of age (42.5 [IQR = 30.0–59.5] vs. 37.5 [IQR = 27.3–64.3], $P = 0.83$), sex (100% vs. 72% male, $P = 0.08$), severity and level of injury (66.7% vs. 76.0% AIS grade A, $P = 0.67$), and burden of associated injuries (Injury Severity Score of 26.0 [IQR = 24.0–30.0] vs. 26.0 [21.0–29.5], $P = 0.53$). Individuals followed at 6 and 12 mos after injury also showed the exact same proportion of BCR in the postoperative period (60.0% in both groups, $P = 1.00$).

Tables 2 and 3 show the AIS grade conversion rate and the NLI improvement based on the postoperative BCR status from the initial assessment to the follow-up evaluation. Among the 45 patients included, baseline and follow-up data regarding AIS grade conversion rate were available for 36 patients, whereas data regarding NLI improvement were available for 31 patients. As shown in Table 2, a total of 50% of the entire cohort (42% for individuals sustaining an initial AIS-A SCI and 70% of individuals with AIS-B injury) showed at least one AIS grade improvement during that period. A higher number of individuals with a BCR in the postoperative period reached at least one AIS grade of conversion (55% for group 2 vs. 43% for group 1) in the subacute to chronic period after the injury; however, this result was not significant (Table 2). Although AIS motor score was similar for both groups in the postoperative period (median = 50.0 [IQR = 21.5–72.0] vs. 50.0 [IQR = 32.0–51.6], $P = 0.29$ for groups 1 and 2,

TABLE 1. Baseline characteristics of individuals with a motor-complete TSCI based on the presence of a BCR in the postoperative period

	Entire Cohort *N* = 45	Group 1 (BCR−) *n* = 18	Group 2 (BCR+) *n* = 27	*P*
Age, median (IQR), yr	36.0 (28.0–60.3)	46.0 (25.5–63.0)	35.0 (30.0–55.0)	1.00
Sex, male, %	84.1	82.4	85.2	1.00
Initial SCI severity, AIS A, %	71.1	61.1	77.8	0.32
Initial NLI,%				0.27
C0–C4	34.1	43.8	28.0	
C5–C8	31.7	37.5	28.0	
T1–T8	12.2	12.5	12.0	
T9–L1	22.0	6.3	32.0	
CCI, %				0.69
0	93.3	94.4	92.6	
1	4.4	5.6	3.7	
3	2.2	0	3.7	
TBI, %				0.67
None	40.9	44.4	38.5	
Mild	56.8	55.6	57.7	
Moderate	2.3	0	3.8	
Severe	0	0	0	
ISS, median (IQR)	25.0 (21.0–29.0)	25.0 (21.0–30.0)	26.0 (21.0–29.0)	0.48
Surgical delay (<24 hrs), %	59.1	61.1	57.7	0.54
Complications, %				
Pneumonia	42.2	33.3	48.1	0.37
UTI	24.4	27.8	22.2	0.73
PU	42.2	33.3	48.1	0.37
At least 1	84.4	77.8	88.9	0.28
Length of stay, median (IQR)	25.5 (18.0–43.0)	28.0 (16.0–49.5)	25.0 (19.0–32.0)	0.68
Surgery to postoperative examination, median (IQR), d	4.0 (1.0–8.8)	6.0 (2.0–11.0)	3.0 (1.0–8.0)	0.56
Trauma to postoperative examination, median (IQR), d	5.5 (2.0–11.3)	7.0 (3.0–12.5)	4.0 (2.0–9.0)	0.68

CCI, Charlson Comorbidity Index; ISS, Injury Severity Score; PU, pressure ulcer; UTI, urinary tract infection.

respectively), individuals with a BCR in the postoperative period showed a higher motor recovery at follow-up. However, this result did not reach a significance level (median AIS motor score of 50.0 [IQR = 27.0–85.0] vs. 69.6 [IQR = 34.0–94.8] for groups 1 and 2, respectively, $P = 0.22$). Table 3 shows a tendency toward a higher proportion of improvement of the NLI at follow-up for individuals with a BCR in the postoperative period (47% for group 2 vs. 8% for group 1). However, this result did not reach a significance level ($P = 0.09$).

Figure 1 shows the functional status (SCIM subscores and total score) 6–12 mos after injury for both groups. Again, individuals with a BCR in the postoperative period showed higher functional scores at follow-up; however, it did not reach a significant level. Finally, Table 4 presents the final GLM showing

TABLE 2. The ASIA Impairment Grade conversion rate for individuals with a motor-complete TSCI based on the absence or presence of the BCR in the postoperative period (*n* = 36)

	Initial Assessment, AIS Grade		6- to 12-mo Follow-up Assessment, AIS Grade					% CR	Mean % CR per Group	*P*
			A	B	C	D	E			
Entire cohort	A	26	15	4	2	5	0	42	50	—
	B	10	0	3	3	4	0	70		
Group 1	A	8	6	2	0	0	0	25	43	0.56
	B	6	0	2	2	2	0	67		
Group 2	A	18	9	2	2	5	0	50	55	
	B	4	0	1	1	2	0	75		

The following letters refer to the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) severity of the injury: AIS grade A refers to a complete severity of the injury; B, sensory-incomplete injury; and C, a motor-incomplete injury.

CR, conversion rate.

TABLE 3. Neurological level of injury improvement for individuals with a motor-complete TSCI based on the absence or presence of the BCR in the postoperative period ($N = 31$)

	Initial Assessment, NLI		Follow-up Assessment, NLI				% IR	Mean % IR per Group	P
			C0–C4	C5–C8	T1–T8	T9–L1			
Entire cohort	C0–C4	13	9	4	0	0	31	16	—
	C5–C8	8	1	6	1	0	13		
	T1–T8	4	0	0	4	0	0		
	T9–L1	6	0	0	1	5	0		
Group 1	C0–C4	7	6	1	0	0	14	8	0.09
	C5–C8	2	1	1	0	0	0		
	T1–T8	2	0	0	2	0	0		
	T9–L1	1	0	0	0	1	0		
Group 2	C0–C4	6	3	3	0	0	50	47	
	C5–C8	6	0	5	1	0	17		
	T1–T8	2	0	0	2	0	50		
	T9–L1	5	0	0	1	4	0		

IR, improvement rate.

the association between the absence of BCR in the postoperative period and the total SCIM score 6–12 mos after TSCI. The BCR status was not revealed as a significant factor associated with the functional outcome ($P = 0.38$), whereas the absence of medical complications during the acute care hospitalization and a lower NLI were significantly associated with a higher global functional status (total SCIM score) 6–12 mos after injury. This model was significant ($P = 0.07$) and expressed 48.5% of the variance for the outcome.

DISCUSSION

This is the first study, to our knowledge, to investigate the clinical significance of the presence of a BCR on the functional outcome after a motor-complete SCI. Despite studies showing the importance of evaluating the BCR status,[11] its clinical interpretation remains largely unclear for this specific population. However, a better understanding of the functional impact of the absence of the BCR in the postoperative period for individuals with severe TSCI could help in refining the prognosis estimation in the early acute phase after the injury. It may also help better understand the spinal shock, a complex clinical concept that is still often considered as a limitation to the acute neurological examination interpretation.[16]

Despite a lack of statistical significance probably related to the low number of patients included in this study, overall improvements of motor score, NLI, and AIS grade conversion rate for the BCR+ group suggest that the BCR status in the postoperative period, reflecting the time course of the first phases of the spinal shock,[12] may be influenced by the severity of the injury. Thus, this factor may deserve attention in future prospective studies as a potential clinical predictor, available at admission to acute care, of the long-term functional and neurological outcome in motor-complete TSCI. This study may suggest that a late recovery of the BCR may help in refining the prognosis estimation for individuals sustaining motor-complete injury, which represents more than 30% of the Canadian TSCI population.[30] Although motor-complete TSCIs are generally associated with limited outcomes,[6–10] there is a considerable amount of variability in terms of neurological and functional recovery with 20% regaining sensory or motor function caudal to the injury (conversion to AIS-B or AIS-C grade).[15] Therefore, the status of the BCR in the postoperative period could help clinicians improve the early prediction of the

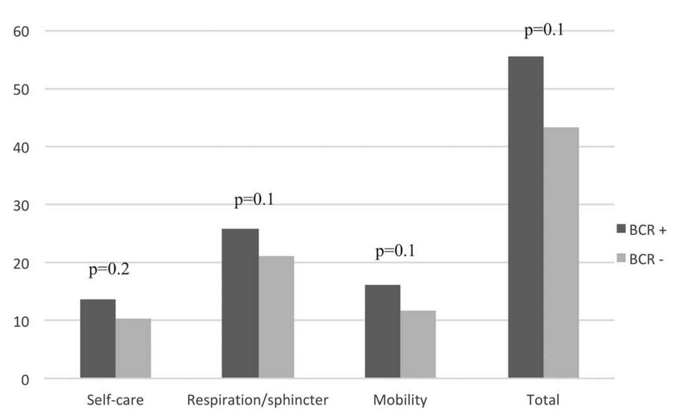

FIGURE 1. Comparison of the functional status (SCIM sub scores and total SCIM score) 6–12 mos after a motor-complete TSCI based on the BCR status in the postoperative period ($N = 45$).

TABLE 4. The absence of the BCR in the postoperative period after a motor-complete TSCI and its association with the chronic total SCIM score: Results of the final general linear model (N = 45)

	β Coefficient (95% CI)
Absence of BCR	−10.7 (−24.3 to 2.9)
Absence of any complications during acute care	25.9 (7.5 to 44.2)
Initial NLI	
C0–C4	−16.1 (−40.5 to 8.3)
C5–C8	−13.5 (−35.5 to 8.5)
T1–T8	0.04 (−23.1 to 23.1)
T9–L1	Reference category
Initial AIS motor score	0.27 (−0.3 to 0.8)

R^2 value = 0.485.

outcome after an acute motor-complete TSCI, facilitating the establishment of an appropriate rehabilitation plan and efficient utilization of resources.

Because the spinal shock may be due to a sudden loss of the descending facilitation from the central nervous system, the occurrence of spinal shock is associated with complete SCI.[12,29] To our knowledge, this is the first study to also report the absence of BCR in sensory-incomplete injuries, with 53.8% of AIS-B patients showing no BCR in the postoperative period.

Moreover, this study may add knowledge on the time course of reflex recovery during the spinal shock. Ditunno et al.[12] published in 2004 a thorough review on the physiologic pattern of the spinal shock after an acute TSCI. In this review, a four-phase model is presented, where the recovery of the BCR is suggested to occur within the first 24 hrs after the injury (phase 1), becoming stronger thereafter until 72 hrs after the injury (phase 2). Although this review article focused on complete injuries, results of the current study may suggest that the time course of the spinal shock could extend beyond that and may be influenced by different factors such as the initial severity of the injury. However, future studies using a prospective design should investigate longitudinally the time course of spinal reflexes caudal to the TSCI to clarify these hypotheses.

Finally, the BCR status in the postoperative period was not revealed as a predictive factor of the functional outcome in our final GLM, which may be due to limitations of this study. Results of the final GLM, however, showed the importance of the initial characteristics of the TSCI and the occurrence of medical complications during the acute care hospitalization on the subacute to chronic functional status (Table 4), supporting previous literature on TSCI prediction models.[6,8]

Study Limitations

Results of this study should be interpreted considering limitations. The main one relates to its retrospective nature as well as the low number of patients included in the final cohort, which limit the power of this study. Nevertheless, this study has brought important preliminary results that may now deserve more attention in a prospective study to issue clinical recommendations.

Unfortunately, the BCR was not systematically evaluated upon presurgical evaluation, and this information could not be used in the analyses. As a result, the clinical interpretation of the presence of BCR in the postoperative period is limited, as the presence of BCR could either be associated with the absence of spinal shock or to a quicker recovery process of the spinal reflexes. Nonetheless, both possibilities support our results, as both suggest a lesser severity of the injury and subsequent higher outcome. This study also highlights the importance of performing the BCR in the presurgical period, despite potential difficulties to perform a complete physical examination in the early acute phase after TSCI due to mobility restrictions, pain, and/or anxiety. Moreover, the timing of examination in the postoperative period was different (though nonsignificant) for both groups. This is not likely to have influenced results of this study, as the delay of assessment was longer for individuals without a BCR, supporting the higher delay of spinal reflexes recovery in this group.

Finally, both the 6- and 12-mo follow-up SCIM scores were considered all together. Although a study claimed their differences be statistically insignificant,[26] a future prospective study should take this into consideration to hopefully obtain statistically significant results, thus improving prediction techniques and patient care.

CONCLUSIONS

Lack of literature regarding spinal shock and the BCR, despite common consensus that spinal shock is associated with poor outcome, prompted the realization of this study. Its purpose was to compare the functional outcome 6–12 mos after a motor-complete TSCI based on the BCR status in the postoperative ISNCSCI examination. This study showed that 40% of patients sustaining a motor-complete (AIS A or B) TSCI (excluding any involvement of the conus medullaris) did not have BCR 7 days after trauma. This study also suggests that the absence of BCR in the postoperative period, suggesting a late recovery process of the spinal reflexes as part of the spinal shock, may be associated with poorer neurological and functional recovery in the subacute to chronic phase after a motor-complete TSCI. However, results did not reach a significance level, most likely because of a low number of patients included in this study, and thus, a future larger prospective study should confirm these results. This study also suggests that the time course of the spinal shock may extend beyond the previous timeline proposed by Ditunno et al.[12] in 2004 and may be influenced by the severity of the injury. Thus, future studies may investigate the BCR status in the postoperative period as a potential clinical factor, available from admission to acute care, refining the neurological and functional outcome predictors after a motor-complete TSCI.

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